

EXPLORING AND SETTLING PACIFIC OCEAN SPACE
PAST ANALOGUES FOR FUTURE EVENTS?

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We are an exploring species. We have spread over the face of our globe, walked on the Moon, sent probing instruments to neighboring planets, and now stand on the threshold of settling space. Scenarios abound in futuristic prognostications, and especially in science fiction, of how human settlement in space will unfold, and how leaving our terrestrial cradle will transform human society. However, my task here is not to analyse these, but to look at the exploration and settlement of Earth to draw out experiences which might provide some insight into the human dimensions of this next phase in our expansion.

For the first few million years our distant ancestors explored only the land. They started as ground-dwelling primates who, from a presumed African homeland, spread over Africa, Asia and Europe. Walking upright, facing the world heads up and with hands free, they used their evolving intelligence and developing technology to occupy a wide range of niches spread over these interconnected land masses. Then some 50,000 years ago some of our predecessors, now fully Homo Sapiens, took advantage of lowered sea levels during the glacial advance then to occupy three more continents. The ancestors of the American Indians walked across the Bering Straits land bridge, while those of the Australian Aborigines and New Guineans rafted over short water gaps between the greatly enlarged Indonesian extension of Southeast Asia, and the super-continent made up of today's Australia and New Guinea plus the surrounding continental shelf.

The exploration of the sea, the other 70% of our globe's surface, came last. Only a few thousand years before Christ did people begin to sail far out into the ocean, to search for and settle isolated islands, or to reach distant continental shores. The ocean then was a vast unknown. Our ancestors were less informed about what lay over the horizon than we are today about what is to be found in near space. To breach this unknown, to sail where no one had sailed before, required extraordinary vision, dedication and perseverance, and a giant leap forward in technology: the development of craft able to survive long periods in an alien environment; of sails to harness the wind's energy; and of ways to navigate 'once sight of land was lost. These prerequisites, plus the lonely isolation of those first to settle on mid-ocean islands, make

the human experience in the exploration and settlement of ocean space worth examining by those facing the coming movement into outer space.

Who were the first to explore the ocean--to develop a deep-sea technology and mentality? Western accounts of early seafaring evolution typically dwell on the Mediterranean. Yet, if we had the advantage of time-lapse satellite photographs which extended back to say 5,000 B.C., and which were of sufficient resolution to pick out small watercraft, we would find that while Egyptians, Minoans, Greeks and Phoenicians were learning to sail the Mediterranean, a more daring, more oceanic, seafaring movement was developing in Southeast Asia. This is the Austronesian seafaring tradition which, focused on canoes rather than ships, was to extend across two oceans, the Indian and the Pacific.

Because the vastness of the Pacific, one-third of the world really, and the isolation of its islands from continental shores, posed such a great challenge to the human spirit and ability for technological innovation those interested in the human aspects of moving into space may find it most interesting to examine the record of the exploration and settlement of this greatest of oceans. I will introduce this perspective by first sketching the outline of the prehistoric penetration of the Pacific by Polynesian canoe voyagers, and the later history of the European exploration of that ocean. Then I will consider those experiences in each development which appear to relate most directly to those we may undergo in exploring and settling space.

I

Of those small bands of Austronesian seafarers who pointed their canoes east toward the Pacific, the Polynesians went the farthest, reaching Hawaii and Easter Island on the far eastern side of that ocean, and perhaps also landing on the American coast. Their Pacific odyssey began around 1,500 B.C. on islands off the north coast of New Guinea, and extended eastward over the next two and a half millenia with a series of progressively longer voyages culminating in the settlement of Polynesia proper, a vast triangular area equal in size to much of Europe and Asia combined. To gain some idea of this accomplishment, cast the Polynesian

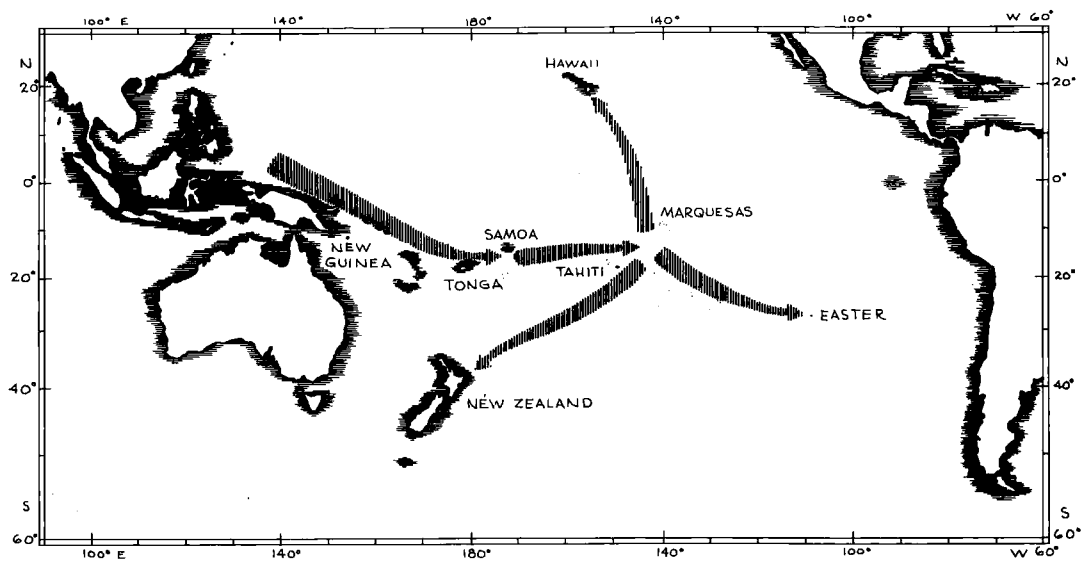


Figure 1 The Polynesian Migration Trail.

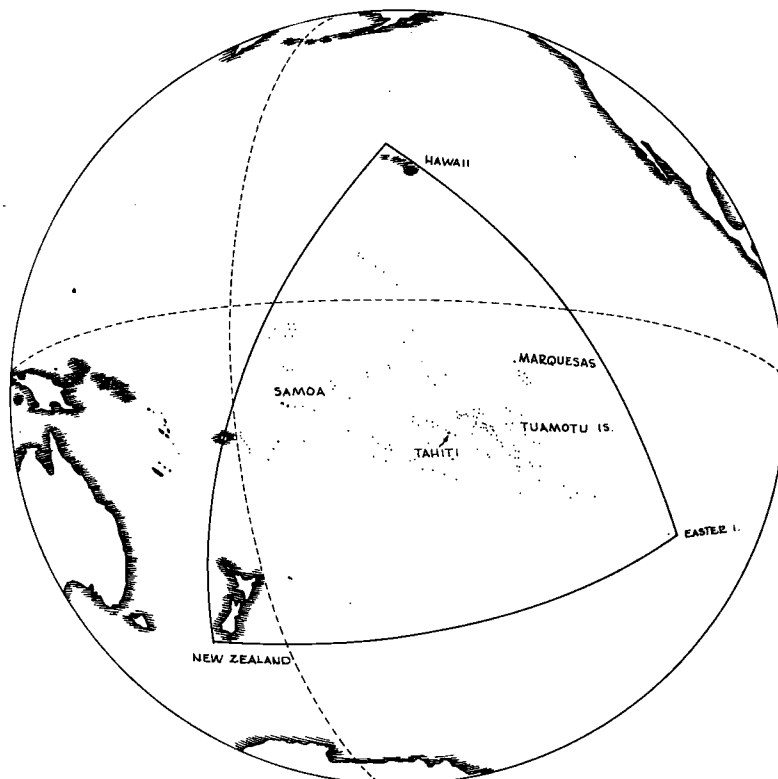


Figure 2 The Polynesian Triangle.

triangle, bounded by New Zealand, Hawaii and Easter Island, onto the Eurasian continent and you will see that it would extend from London to the eastern tip of Siberia, and from there down to India and back up to London.

The development of the Polynesian voyaging canoe, the "Spaceship of the Ancestors" as one Polynesian patriot calls this stunning achievement of Stone Age technology, followed from the challenge of the increasing inter-island distances and carrying requirements involved in exploring and settling the Pacific.¹ As the migrants moved farther east into the ocean they had to sail first a hundred or so kilometers to reach the next island group, then hundreds, and finally, on the extreme periphery of Polynesia, thousands of kilometers to find new land. In addition, they discovered that as they moved into the Pacific the new islands lacked the plants and animals they and their ancestors had exploited in the richly endowed islands on the western edge of the ocean. They found little to eat on their new discoveries but fish, seabirds and seabird eggs. All this added up to a need for a craft which would be larger and more stable than their original simple outrigger canoe, a craft which could carry scores of men, women and children on long voyages, sufficient water and food to keep them alive for weeks on end, and also a precious cargo of domesticated animals (pigs, dogs and chickens) and cultivated plants (taro, yam, banana and many others) Polynesians needed to recreate their accustomed way of life on the fertile but biotically impoverished islands they found in mid-ocean.

Their solution was the double-canoe, the ancestor of today's catamaran. Its twin hulls provided the needed carrying capacity, and stability, far exceeding that of the simple outrigger canoe that had brought them to the edge of the ocean. Although we do not know the dimensions of these Polynesian arks, judging from the requirements of the long voyages, and the canoes seen much later by European explorers, a 20 meter long double canoe, capable of carrying 20 to 30 colonists along with their supplies, animals and cultigens, would seem a reasonable estimate for an average voyaging canoe of that day.

To power their craft Polynesians rigged triangular mat sails fore and aft to sail across, and into the wind as well as before the wind. The efficiency of their sail rigs can be judged by their accomplishments. By about 1,200 B.C., when Minoans, Greeks and other ancestral Western sailors braved their square-rigged vessels on short voyages within a near land-locked sea, Polynesians had reached Samoa and Tonga in the middle of the world's greatest ocean. To accomplish

this, generations of canoe sailors had to work their way slowly, from island to island, eastward against the direction of the prevailing southeast tradewinds and south equatorial current. However, they did this more through seamanship than pushing directly toward windward. They were good enough meteorologists to learn the weather patterns and how to wait for the brief periods of westerly wind reversal in order to run east before the wind, an excellent exploring strategy that also allowed them to come home again once the tradewinds came back into force.

The ancient Polynesian seafarers also had to be good naked-eye astronomers, as well as acutely sensitive to the pattern of the sea swells, the habits of land-based birds and how clouds formed over islands, for they used these and other cues supplied by the oceanic environment to navigate from one distant island to another. They sighted on horizon stars to set their course, employed zenith star observations and finely honed dead reckoning skills to keep track of their progress, and watched the deflection of sea swells, as well as the appearance of shore-dwelling birds and banks of clouds, to home in on their landfalls. We know of the surprising accuracy of these skills not just from legend, or from partial accounts dating back from the European contact period, but also from the recreation of a near 10,000 kilometer round trip voyage between Hawaii and Tahiti recently sailed on a reconstruction of an ancient voyaging canoe using only Polynesian non-instrument methods to navigate.

Once these seafarers had reached Samoa and Tonga, they had far outdistanced their rivals and were alone in the ocean. There in splendid isolation that culture we know as Polynesia took its basic form, and from there, after a millenium long pause, the canoes headed east once more. Archaeologists tell us they crossed first to the Marquesas, and that in the space of a few hundred years, they sailed from there and neighboring Tahiti, to the most distant islands to be colonized: Easter Island, Hawaii and New Zealand, the points of the Polynesian triangle. However, after around 1,200 A.D., the Polynesian penchant for migration and voyaging seems to have waned as they settled down on their island discoveries and concentrated more on island living than oceanic wandering.

So the Polynesian potential was limited. If they went farther east and landed on American shores, and this is not yet known, they were no more successful in establishing permanent colonies there than were their Viking counterparts on the Atlantic coast. Their Stone Age naval architecture did not advance beyond the voyaging canoe to more sophisticated craft. In fact, particularly on the large and fertile islands deep-sea canoes and navigational skills regressed as people

turned to the land and to elaborating local island cultures. Nor did their extraordinary stellar navigational system lead to anything like the development of science. Although in terms of their rich art, stirring oral literature and a life style that so charmed sailors and philosophers alike, Polynesian civilization can hardly be termed a failure, as an experiment in human migration it was a dead end.

In the early 1500's, a few centuries after the last wave of Polynesian wandering had subsided, ships from half way around the world began to sail into Pacific waters. By then the European age of exploration had dawned. In the previous century, tiny Portugal had sent its caravels down the unknown African coast, then around the tip of Africa and across the Indian Ocean to India. Portugal's quickly established monopoly over this Indian Ocean route to spices and other riches of Asia piqued her Castillian neighbors whose rulers then backed a visionary Genoese seaman who claimed that Asia could be reached directly after only a few weeks sailing due west from the Canary Islands. In 1519, once it was finally realized that the lands Columbus had discovered were not outliers of Asia but part of a New World, Spain--now backing a Portugese adventurer rejected by his own king--sent an expedition to find a way past this New World barrier to Asia.

At this time, Europeans had no real conception of the Pacific Ocean. True, Portugese explorers had penetrated to its western edge (as had Marco Polo a few centuries earlier), and Balboa had gazed upon a great body of shining water he named "The South Sea" because of the east-west lay of the Panamanian Isthmus he crossed to gain this first European view of the Pacific's eastern shore. But, that it might be many thousands of kilometers from Panama to Asia, that this sea might in fact comprise one-third of the world's surface, was hardly even suspected. Magellan and his men learned of the Pacific's extent the hard way. Upon clearing the straits that now bear his name, Magellan headed north along the South American coast, then struck out west-northwest in the belief that Asia lay only a few weeks sail away. Three months and twenty days later the scurvy-ridden survivors landed in the Phillipines, having sighted only four islands, three of them tiny uninhabited atolls, during their grueling traverse of that calm, blue expanse.

So was inaugurated the century in which the Pacific was to become known as "The Spanish Lake."² By European historians, that is. For most Polynesians never saw a Spanish ship, and fortunately never experienced Spanish muskets or swords. Why? Because the Spanish primarily ventured into the Pacific to get to the other side as quickly as possible--

to reach the Spice Islands, or later to carry Mexican silver and Chinese goods back and forth between Acapulco and Manila. Their "hurry across" strategy, which was dictated by a primitive sailing and navigational technology only barely adequate to cross the ocean provided they did not tarry to explore, as well as their driving desire for commerial gain, interacted with the trend of the island chains and the pattern of oceanic wind circulation to practically guarantee that most mid-Pacific islands would remain unknown to the Spanish.

Most of these islands lie in long chains which, because of the way magma has periodically punched through the west-northwestward moving Pacific Plate from a series of fixed geological hot spots, trend east-southeast to west-northwest, parallel to the transpacific routes dictated by the prevailing easterlies and westerlies. Thus, the Manila galleons were to ply the Pacific for centuries without encountering a Polynesian island. First they sailed west from Acapulco with the easterly tradewinds behind them on a course which took them between the Hawaiian chain and the other Polynesian archipelagoes that lie to the south. Then they returned by sailing north from the Phillipines until, at a latitude well above Hawaii, they caught the westerlies which took them through North Pacific waters bereft of islands all the way to the North American coast.

Nonetheless, during the Spanish century, a few visionaries did emerge to persuade the Spanish authorities to dispatch a series of three expeditions to explore the Pacific in search of rich islands, and a fabulous "Southern Continent" rumored to be there. Although each expedition returned with news of islands found, the effort came to nought. The lack of gold or other riches on the islands discovered, and the high price of mounting such expeditions, made the cost-conscious bureaucrats of the soon to decline Spanish empire summarily disapprove applications for further voyages into such an obviously unprofitable void.

The Dutch, who in the 17th century replaced the Spanish as the foremost maritime power in the world, were in an excellent position to explore the Pacific. By outsailing and outgunning the Portugese, they took over much of the latter's Asian empire which put them firmly in Indonesian waters at the western threshold of the Pacific from whence had earlier issued the Polynesians. But the burghers directing the East India Company which held monopolistic rights over Asian and Pacific commerce and voyaging were no more anxious to explore the Pacific than had been their Portugese predecessors. The Company had the riches of Asia at hand and that was enough. Thus they sent only one, tentative, expedition into the Pacific, after

which they dropped the notion of Pacific exploration and even went so far in preventing other Dutch ships from sailing on the ocean that they confiscated the vessels of two maverick Dutch expeditions that sailed across the Pacific from east to west in futile attempts to avoid the Company blockade.

Although these three Dutch voyages did add to the short list of known islands, the resulting knowledge did not add up to any profound understanding of the Pacific. Although, for example, a few Polynesian groups had been touched, there was no realization of the vast extent and cultural unity of the Polynesian world. Furthermore, the failure to probe into temperate latitudes of the South Pacific (for want of adequate ships, nourishing voyaging foods and an accurate navigation system) left the existence of the hypothesized continent, the Terra Australis Incognita so beloved by armchair geographers of the age, still to be confirmed or denied.

The actual European exploration of the Pacific was to be left for the following century and to fall primarily to England, the next European nation to rise to maritime ascendancy. But it did not happen immediately. The first English voyages across the Pacific during the 18th century hardly improved upon the record of Sir Francis Drake who, after harrying Spanish colonies and shipping, fled across the Pacific without sighting an island until at its western edge. It was not to be until Captain James Cook sailed into the Pacific that the world was to gain a comprehensive knowledge of what lay in that ocean. In three epochal voyages between 1768 and 1780 Cook discovered, or fixed the position of, a multitude of oceanic islands, realized the extent and unity of Polynesia, and disproved the existence of a Southern Continent in temperate latitudes (although he rightly suspected that a continent lay far to the south).

But these discoveries were not solely due to Cook's genius. Like the Polynesians before them, the Europeans responded to the challenge of deep-ocean sailing by improving their technology. By the late 1700's their vessels were much more seaworthy than those first ships of Portugal and Spain, progress had been made in preventing scurvy, that scourge which had previously carried away so many sailors, and the vital element missing from the European navigation system had been added. Previously, European navigators were much less accurate than their Polynesian predecessors, for although they could find their latitude they could only guess at their longitude. Now, with the perfection of the marine chronometer, they could determine longitude and thus "fix" their position, and that of any islands discovered, exactly on the globe.

The age of scientific exploration had dawned.³

II

What motivated this exploration of the Pacific? What drove the Polynesians, then European explorers, to set sail over the Pacific, to pit their craft and themselves, in a race to reach new lands before being overwhelmed by the sea or the ravages of scurvy and thirst? The dangers faced by Pacific pioneers can hardly be exaggerated. Elsewhere I have estimated that as many as a half a million Polynesians may have been lost at sea, and we have only to read the account of Magellan's horrendous crossing to realize the toll the ocean took on early European explorers. What, in other words, were the rewards for such dangerous undertakings? Were they solely material? Were the Polynesians driven to seek new island homes just because of population pressure? Were early European explorers seeking solely the riches of Asia or of even more fabulous lands? Or, were these pioneers driven by a more basic drive in human nature to explore?

The opening sentence of this paper gives away my sympathies, although I admit, as every advocate of the "it is in man's nature to explore"⁴ thesis must, that exploration results from both materialistic and humanistic motives. Thus, any exploration of Polynesian migrations would be incomplete without a reference to population pressure on small islands as a force behind seeking new island homes. Yet, population pressure alone cannot explain why Polynesians chose to go farther and farther into the unknown ocean to seek lebensraum, or why within a few centuries they exploded over the Polynesian triangle, discovering and settling islands at a rate that far outdistanced their ability to multiply beyond the carrying capacity of each successive island in the series. The Polynesian spirit of adventure, their bent for taking to their canoes to see what lay over the horizon, traits remarked upon by early Western explorers and celebrated in Polynesian chants and legends, must be part of any attempt to explain the Polynesian odyssey.

Similarly, while historians may stress the commercial motivation behind European expansion overseas,⁵ greed for spices, gold and other treasures does not explain all. To be sure, Columbus, Magellan and other pioneering navigators sought riches. But, in reading about they developed their theories of new routes and lands, and of their struggles to convince skeptical authorities of the soundness of their ideas, one cannot help but feel that their proposed voyages and geographical discoveries were their real dreams, and that the prospect of great riches was as much as anything the bait they held out

in order to obtain funding from dubious monarchs and their advisors.

Let me explore this thesis with a more obscure explorer, Pedro Fernandez de Quiros, a skilled navigator who found himself on the coast of Peru in the last decade of the 16th century. There he reluctantly agreed to serve as chief pilot for Mendaña, a Spanish aristocrat who in 1567 had sailed into the South Sea in search of the land of Ophir from whence King Solomon had obtained his gold, but only found a Melanesian archipelago adjacent New Guinea which he named the Solomon Islands. In 1595, with Quiros as his chief pilot, Mendaña sailed for the Solomons with three ships, soldiers and colonists to settle and exploit his discovery of three decades before. The voyage was a disaster. For want of an accurate navigation system the Solomons could not be found again. In the Santa Cruz Islands, a nearby Melanesian archipelago they happened upon, dissension, disease and Melanesian arrows killed many of the would-be colonists, including Mendaña. Nonetheless, when after still more hardships, the once reluctant Quiros returned to Peru, he was ready to turn around and head right back into the Pacific. Now he knew what was to be found there: not merely the gold mines of a biblical king, or the Solomon Islands Mendaña had found, but the fabled Southern Continent.

When the Viceroy of Peru gave him no encouragement, Quiros sailed for Spain to seek the king's support. But the potential riches of an hypothesized continent were not bankable to the monarch of a country which was having trouble administering an already overextended colonial empire. So Quiros headed for Rome to seek the Pope's support. Now the conversion of the souls of the millions who must inhabit the Southern Continent was the bait. There Quiros succeeded. He won the Pope's blessing which in turn unlocked the Spanish treasury, and in 1605 he was sailing west from Peru once more.

The voyage was undistinguished. No sign of a Southern Continent was found, and only a few islands of no obvious value were raised. Still, upon his return, the obsessed Quiros petitioned to be sent out once again. This time he was turned down totally, until the Spanish crown seemingly relented and sent him back to Peru. It was cruel ruse. The ministers of Spain's empire saw no profit in wasting more money. Their secret orders to the Viceroy were to stall Quiros and by no means give him any ships. Fortunately, the worn-out navigator died en route, ignorant of this bureaucratic duplicity.

A more modern personification of this exploring urge is found in England's Captain James Cook, the archetypal seaman-explorer (and prototype for Captain James Kirk of the Starship Enterprise?). In 1768

Cook, after rising through the ranks from a common seaman, was tapped to command a scientific expedition to sail to Tahiti and there observe the transit of Venus across the sun in order to, in conjunction with observations made elsewhere in the world, determine the distance to the sun. Once Cook ably performed this task, he was directed to carry out the secondary mission of exploring the ocean south of Tahiti for the Southern Continent. Thus Cook came to be, as he himself phrased it, "employed as a discoverer"⁷ for the remainder of this expedition, and for two more voyages into the Pacific, which together were to fill in the map of the ocean so completely that subsequent explorers were to complain that little was left to be done but fill in the details.

Cook, whose journal rarely reveals his innermost thoughts, once let down his guard while sailing far to the south into icy Antarctic waters. Satisfied that he had done all that was humanly possible to search out the hypothesized Southern Continent, Cook penned this admission of the personal motivation which drives the explorer:

I whose ambition leads me not only farther than any other man has been before, but as far as I think possible for a man to go...⁸

Still, however much these navigators personified the exploring thrust of that age, however much they might have felt themselves victimized by economy-minded bureaucrats, their expeditions were very much national enterprises. Only nation-states could afford to mount these voyages which might require up to three ships, hundreds of men and several years to complete. A corollary to this is that Pacific exploration came to be a field of intense national competition. At first this competition was overwhelmingly commercial as rival European powers sought access to the riches of the Orient, or those of undiscovered South Sea lands. By the time of Cook, the emphasis was shifting to the scientific, although this was never entirely divorced from colonial ambitions. From Cook onwards, the prizes to be won in Pacific exploration were the discovery of new islands, the specification of their exact geographical location and geological composition, descriptions of their floral and faunal life, and plant and animal specimens as well, including exotic islanders, to be brought back for examination by the scientists of the day.

Britain and France, by then the leading European nations, led this competition. Although Cook's three voyages established a great lead for the British, the French attempted to catch up by mounting more intensive and precise surveys, and by concentrating on geophysical, meteorological and oceanographic observations. According to John Dunmore, the

historian of this French effort, the intense national rivalry between Britain and France, involving the expenditure of what in those days were great sums of money and an unprecedented mobilization of scientific resources, anticipated the space race of the 1960's.⁹

Russia, it is interesting to note, was also ran in this competition, and the United States was the last to start. Russian explorers did not really start sailing into the Pacific until the early 1800's, and the first American effort, pridefully named "The United States Exploring Expedition," did not reach the Pacific until 1839, sixty years after Cook and three centuries after Magellan!

A human problem which sociologist B.J. Bluth sees as assuming critical importance in future manned space missions was first encountered in these early scientific voyages to the Pacific.¹⁰ That is, how do two types of people, different in training, character and goals, work together effectively in close confines for long periods of time in a difficult and alien environment? The experiences of Cook's voyages are especially illuminating.

His first voyage stands as a milestone in the incorporation of both scientific tasks and scientific personnel into an exploring expedition. The scientific accomplishments of that voyage were many: nearly forty islands were found and firmly located on the map; rigorous dietary measures demonstrated how scurvy could be prevented; over a thousand different plant specimens unknown in Europe were collected; the first evidence of Polynesia forming a great "nation" spread over the Pacific was uncovered; and as noted the transit of Venus was observed. Cook's principal collaborator was Joseph Banks, a wealthy young naturalist who financed his own way, and that of his scientific staff. The inquisitive Mr. Banks, the future president of Royal Society, fortunately did not confine his activities to his speciality of botany. He was especially adept in what now would be called anthropology, and his quickly won knowledge of Tahitian, along with his cultural acuity and diplomatic skills, served the expedition well. For example, during their long stay on Tahiti, Cook employed Banks to help keep on good terms with the Tahitians and make sure the ship received a steady supply of fresh foods. Furthermore, Cook and Banks apparently got along well personally, as well as professionally, dining together regularly during the two years they were at sea, and evidently discussing at length and with mutual profit, the questions raised by their discoveries.

But this seemingly genuine partnership of seaman and naturalist did not last. Banks was too presumptuous, and Cook's patience with scientists and science was too thin.

The break may have started as soon as the H.M.S. Endeavour returned to England. At first the press and public singled out Banks so much that the expedition became known for a time as "Mr. Bank's voyage." Then, when the lionized Banks went to prepare for the second voyage, he recruited so large a staff, and gather so much scientific paraphernalia, that virtually an extra deck of cabins had to be added to the ship to accommodate all the scientists and their gear. When Cook saw this top-heavy addition, he refused to sail until the whole works were removed to bring the ship back into a seaworthy condition. The infuriated Banks promptly resigned.

The Admiralty, still committed to the inclusion of scientists on the expedition, was forced to appoint another naturalist, but their choice, the German scholar Johann Forster, was not a happy one. Although he had undoubted talents, Forster has been described as "dogmatic, humourless, suspicious, censorious, pretentious and demanding."¹¹ One cannot help but sympathize with Cook who, on top of commanding a most difficult mission into Antarctic waters and back and forth across the Pacific, had to put up with such a man on this three-year long voyage.

It is therefore not surprising on his third and last voyage to the Pacific, Cook carried no official scientists. Line officers were assigned astronomical duties, and the ship's surgeon doubled as anthropologist and linguist. Although other factors may well have been at work, it seems probably that after spending five tough years at sea working with a variety of astronomers, botanists and other naturalists, Cook had enough of scientists, their professional demands and personal foibles, and all their instruments and baggage, and was thus delighted to make do with scientifically inclined naval officers. Johann Forster is, of course, hardly the unbiased witness to cite concerning Cook's growing exasperation with scientists, but the quote is too apt to let pass. Forster reported that Cook once exploded with: "Curse all the scientists and all science in the bargain!"¹²

The French followed a similar progression in their Pacific explorations. At first French expeditions tended to be crowded with scientists and their gear. Baudin's voyage to Australia, for example, included twenty-two savants, plus a mountain of stores and equipment. French commanders could not help but complain about these supernumerary specialists who all too often were ignorant of the sea, were so easily frustrated by bad weather and illness, and were so quick to resent naval discipline. By the end of the Napoleonic era, the French abandoned the practice of sending scientists not bound by naval training and discipline on their voyages, and instead appointed naval officers with scientific interests and

aptitudes to do double duty.¹³

The same seamen-scientist conflict came to fore on the lone American expedition. This long-delayed U.S. Exploring Expedition was planned to place the United States firmly among the world powers by demonstrating that she too could mount a major Pacific exploring enterprise. Three ships were to carry an unprecedented complement of scientists who, representing many specialities, were to be charged with making all manner of observations and collections. But, as preparations dragged on, a young naval officer named Charles Wilkes, who had scientific aspirations of his own, asserted his will, and the projected scientific team shrank as appointees resigned or were dismissed. When the expedition finally sailed, with Wilkes in command, all physical scientists had been replaced by naval officers, and those naturalists allowed on board were kept firmly under the despotic thumb of Wilkes.

Only some decades later, once improvements had made ocean travel safer and more routine, was the pattern of scientists going to sea reestablished, as witness the famous Challenger expedition and the growth of oceanographic research since. Yet, judging from a few references in the literature,¹⁵ and from what my oceanographic colleagues tell me, the potential for conflict between those whose job it is to command and crew the research vessels; and those who use them as research platforms, remains.

Turning back to the Polynesians, we can ask how their experience in colonizing remote islands might enlighten those who contemplate settling in space. We are greatly handicapped by the lack of written records of the migratory era for with the partial exception of the Easter Islanders the Polynesians did not write. Thus we cannot delve into the personal and psychological correlates of settling far off places and creating self-contained communities. All we can do is work on a more general socio-cultural scale, offering plausible hypotheses based on what information we have from linguistic, archaeological and anthropological research.

First, the obvious. Polynesians did not establish colonies in the original, Roman sense of a series of outposts connected by roads or sea routes to an administrative center and designed to control and acculturate alien lands, nor in the more modern sense of overseas possessions designed to enrich the mother country. Once Polynesians settled on a new island they were essentially on their own. Where possible they might sail back to their homeland to, say, fetch an economic plant that did not survive the salt spray on the original voyage, or to make a cultural pilgrimage. But a few return voyages, or the occasional arrival of new canoes, did not alter the fact that each Polynesian society

was essentially independent and self-sufficient. In fact, it is difficult to conceive of more isolated and self-sufficient societies anywhere in the world than those on remote Polynesian islands--like Easter Island which, after initial settlement, was almost totally isolated for some 1,200 years until a Dutch ship arrived offshore one Easter Sunday.

The type of society and cultural ethos that led to such extreme examples of self-imposed isolation was bred, think some archaeologists, in the waters of Melanesia off New Guinea. There, small groups of Austronesian canoe people, racially and culturally distinct from the earlier Melanesian inhabitants of New Guinea and the larger offshore islands, came to occupy a marginal niche. They lived on small, unpopulated islands, or remote coastal sites on the larger islands, where their superior canoe technology allowed them to exploit the marine environment and keep their distance from their less marine-oriented Melanesian neighbors--except perhaps when trading between Melanesian groups who lacked the technology to make the voyages themselves.

For these proto-Polynesians to have left this biotically-rich environment to sail into unknown ocean waters might seem like the height of reckless folly to the land-oriented. Yet, it obviously made sense to these seafarers in the light of their long experience sailing from island to island. To them the world was an ocean through which bits of land poked - a more accurate view of our water planet, I would add, than the landlubberly "the world is made up of seven continents separated by bodies of water" characterization that I was taught in school. Thus, they knew that to sail in any direction was to sail towards land. But why did they sail east against the direction of the prevailing tradewinds and currents? Why not sail downwind to the west, the easiest way? Because, we may suggest, they knew that sailing west would land them on inhabited islands where their reception might not be too friendly, and that as they soon discovered, by sailing east they could leave behind their more land-oriented Melanesian neighbors and all the problems of living in already populated regions, and enjoy an ocean of islands to themselves.

What kind of society made this maritime expansion possible? Looking at the different Polynesian groups as we know them from early descriptions and later anthropological studies, Polynesian society seems to have elements of both flexibility and rigidity. The flexibility, I would argue, aided in their wanderings. The rigidity was a result of settling down and becoming too numerous.

Polynesian society was flexible in the sense that: (a) descent and inheritance was not reckoned purely patrilineally

or matrilineally, but in such a way that a person had a choice on whether to affiliate with his father's or his mother's group; (b) children were adopted freely and frequently, and they themselves could seek succour and shelter from a wide range of kinsmen which, in small societies, meant virtually everybody; (c) authority was largely defined in genealogical terms, falling to the senior male of the founder group. These elements would seem to be adaptive for small bands of people, composed of one or several related families, struggling first against wind, sea, hunger and thirst to reach some distant island, and then to survive and multiply in a new and strange environment.

Yet, at the time of European contact many Polynesian societies displayed so rigid a class structure that they rank among the most class stratified societies the world had ever seen. To realize this one has only to read descriptions of the great gulf between chiefs and commoners in ancient Hawaii, and of the despotic power of the former over the latter. Populous Hawaii, where the original canoe-loads of immigrants had multiplied to a quarter million or more, and other highly stratified and amply populated islands lie at one end of a continuum, with the other end occupied by the small islands sheltering a few hundred inhabitants who enjoyed more flexible and egalitarian social arrangements more like those we think characterized the original pioneering groups. Clearly, population growth carries the potential of drastically altering the structure of originally small settling groups.

In another vein, the Polynesian case also underlines the importance of cultural dynamics in settling remote areas. While all Polynesian societies share a common cultural base, each is distinctive. Each seems to have seized upon one feature of the common heritage - be it in religion, warfare, art or whatever - for cultural elaboration. While some of these distinctive cultural developments surely have their ecologically adaptive side, one suspects than random cultural drift, accelerated by extreme isolation, may have been a more powerful determinant in many cases. The immense statues of Easter Island staring so mutely out to sea provide a case in point. Had this lonely island been in frequent contact with other islands, other worlds really, it is doubtful that the Easter Islanders would have devoted so much labor and cultural energy into so unique and exaggerated a development.

The European settlement of the Pacific islands was, of course, just one chapter of a maritime movement started by two small and backward countries sharing an obscure peninsula at the underdeveloped, western end of Eurasia. While a serious consideration of European colonialism would be out of place here, I would like to end this paper by raising one of the tantalizing

"what ifs" of world maritime history.

At the beginning of the 15th century, the Portugese were by no means the leading maritime power of the world. If any country was, it was China, a land with a distinguished maritime tradition going back thousands of years (and probably connected in its early stages with the Austronesian maritime tradition). According to Joseph Needham, the great historian of Chinese science and technology, it was China which pioneered the compass and the stern-hung rudder, two innovations vital to European sea expansion, as well as watertight, compartmentalized hull construction, and full batten sails for windward sailing.¹⁶ Needham believes that China long had the largest and most sophisticated ships sailing anywhere in the world, an opinion you can check by looking at the praise lavished on their stately vessels by those famed medieval travelers, Marco Polo and Ibn Battutah.

Furthermore, early in the 15th century when Prince Henry, that leading light of European maritime progress, was just starting to encourage Portugese sea captains to explore south along the African coast, China was already engaged in sending a series of "treasure fleets" around the tip of Southeast Asia into the Indian Ocean and across to Africa. These peaceful expeditions, which combined diplomatic, commercial and proto-scientific activities, involved the largest collection of ships and men yet seen on the world's oceans. For example, the treasure fleet that sailed to Africa between 1431 and 1433 is reported to have been manned by 27,550 officers and men.

Yet, when Vasco da Gama doubled Cape Horn and sailed up the east coast of Africa and then across to India, he encountered no treasure fleets, no giant, multi-masted junks. The Chinese had left the Indian Ocean, in fact hardly ventured offshore anymore, thus leaving the field wide open for the series of small European nations which were to compete for control of the seas, and as much of the world as possible. Had China not withdrawn, had her great fleets met the comparatively tiny Portugese caravels head on in the Indian Ocean, or perhaps off European shores, how different would have been the course of world history!

What happened? The answer relates directly to the fears that the United States might abdicate leadership in space exploration and settlement. In brief, the anti-maritime party won out over the famed navigator Cheng Ho and the others who advocated a policy of maritime expansion. The Confucian landmen argued that treasure fleets swallowed up too much money which, in the view of all right-thinking bureaucrats of the day, "would be better spent on water-conservation projects for the farmers' needs, or in

agrarian financing, 'ever-normal granaries' and the like."¹⁷ So thoroughly did this internal development policy triumph over the overseas vision of Cheng Ho and his admirals that it became a capital offense even to build a sea-going junk of more than two masts! So china turned inward thereby setting the course of world history for centuries to come. Let us hope that this Chinese maritime experience is not an analogue for our future in space.

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